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II. *The remaining Part of the Observations and Experiments on the Sal Catharticum Amarum, commonly called the Epsom Salt. By Mr. John Brown, Chymist. F. R. S.*

NEAR *Newcastle*, their Method is, to receive the Sea Water into their *Reservoirs* at High-Water, at any Time of the Moon, if there be no Fresh in the River, occasioned by Rain in the higher Country; and from these *Reservoirs*, without exposing of it in Beds, as at *Lemington*, they pump it into their boyling Pans, where, evaporating it almost to a Pellicle, they fill it up again 8 or 9 Times, and then waste it with a gentle Heat for the common or Sea Salt. The Liquor, that runs from this Salt, when taken out, and put into proper Vessels, is what they call the *Bittern*; which if it stands some time in those Vessels, a Salt will shoot and crystalize to the Sides, in Taste pretty much like Sea Salt, but with a share of Bitterness, and seems to answer to the *Cat-Salt* of the *Lemington* Works, and very probably would shoot after the same Manner, if they made use of the same *Apparatus*.

I could not but mention this general and loose Account of making the common Salt, as necessary to introduce the Liquor call'd *Bittern*; which, before Dr. *Hoy* found out an Use for it, was always flung away; being so different in its Properties from the Brine made Use of to produce the Sea Salt, that it would not boil up into a Sea Salt again, and required the nicest Skill and Attendance of the Operator, to determine the Time when to take out the Sea Salt from the Pans,
before

before the *Bittern* incorporated with it, which would otherwise spoil the whole Making.

The *Bittern* at *Lemington* (as observ'd before) not shooting to the Sticks, is carry'd by Channels into Pits made tight with Clay, where it stands for some Months, and there will shoot again: What Liquor remains is boyl'd down, till such Time as it is observed to be in a Disposition to crystalize, and then is convey'd into wooden Coolers lined with Lead: The Liquor, which will not shoot there, is boyl'd down after the same Manner, in order for another Crystalization. By this Time the Liquor seems to have alter'd its Property, and becomes of a very pungent biting Taste, and, if boyl'd down, will no longer shoot into Crystals as before, but precipitates, during the Boiling, a small grain'd Salt; and if you, for Experiment-sake, should continue to boil down the Liquor, separated from this Salt, each Quantity of Salt thus produced, will still be more pungent than the other. If you boil down the whole Quantity of this Liquor, it will produce a Salt, which if expos'd to the Air, will run, *per deliquium*. But as this Salt is not the Business of our present Enquiry, it may probably be the Subject of another Paper. The Liquor, that produces this Salt, is always flung away, wherever the *Sal Catharticum* is made.

This is what, at present, I can give no other Name to, than a third Salt produc'd from the Sea Water, differing, in some respects, as much from the other two, as they differ from one another.

To return to the several Crystalizations, such as mention'd to be shot from the *Bittern*; these will be of different Sizes, as to their Figures, and hold some share of the third Salt but now taken Notice of, which makes them apt to give and dissolve; nor is their Taste come yet to that simple Bitter of the pure Salt. These therefore are either separately, or altogether, to be flung

into a Copper, with as much common Water as is sufficient to dissolve them, and allow of a gentle Evaporation, till such Time as they are again ready to be pour'd into the Coolers in order for Cryſtalization. This generally proves to be the pure *Sal Catharticum*, thoroughly freed (as far as the Experiments I have try'd can be convincive) from either a Sea Salt, or the third Salt. The Liquor decanted from this Shooting, may be boil'd down again in order for a second Shooting, and after that a third; but as the Liquors from these Shootings are boyl'd away more or less, so you will sooner or later meet again with the pungent Liquor, which contains the third Salt, as you did in the former Shootings from the *Bittern*, which the pure *Sal Catharticum* is as necessarily required to be freed from, as from the common Salt; a Proof of which cannot be better determined than by one of the Experiments to be taken Notice of hereafter (*viz.*) that with the *Ol. Vitriol.* which will certainly ferment with this Salt, if the Sea Salt has not been well separated from it, or if it still holds some of the third Salt. And when any of the Cryſtalizations will not stand the Test of this Experiment, they ought to be dissolv'd and shot again, as before, by which means the pure Salt is to be obtain'd. I do not mention this as a Tryal made use of at the Salt-Works, but what I have by Experience found to be true. And the same Experiment will serve to distinguish a *Sal Mirabile* made at these Works, from that made with *Ol. Vitrioli* and common Salt. The Account they give of it is this. They take any Quantity of coarser grain'd Cryſtals boyl'd from the *Bittern*, which when dissolv'd and evaporated, more than they would otherwise do for making the *Sal Catharticum*, they throw into a wooden Bowl, with some Oil of *Vitriol*, where it stands for ten Days, and shoots into large Cryſtals,

Cryſtals, transparent, and like the *Sal Mirabile*: But as this Salt, by this Method, is not ſufficiently ſatiated with the *Ol. Vitriol.* (if they uſe any) ſo it is eaſily diſcovered by the *Ol. Vitriol.* which will readily ferment with it; whereas it has no Effect on the other *Sal Mirabile* made as above.

By the Aſſiſtance of my ingenious Friend, *Robert Cay*, Eſq; at *Newcaſtle*, I have received the ſeveral Shootings of Salts from their *Bittern*, as alſo ſome of the *Bittern* it ſelf; from each of which I have obtain'd a pure *Sal Catharticum*, as alſo the like kind of third Salt, as mention'd from the *Lemington Bittern*. The Method I took in doing it is agreeable to that I have already mention'd, and many Years ago try'd at the Salt-Works near *Portſmouth*. It is by Mr. *Cay* that I am inform'd, they ſometimes boyl their *Bittern* without letting it ſtand any time to ſhoot of itſelf. The Difference is not very material.

If this Account be intelligible, what the *Sal Catharticum* is will no longer be a Myſtery. And the next Thing worth the enquiring into will be, whether this Salt deſerves the Reflections, that have diſcouraged the Preſcription of it? And why it may not paſs for a Salt as excellent in its Kind, and be of the ſame Nature, and have the ſame Properties, as that produc'd from the *Epfom*, or any other bitter purging Springs.

And in order to prove it to be ſo, I ſhall give a very ſhort Abſtract of what Dr. *Grew* ſays of his Salt, and then obſerve how nearly the two Accounts agree.

The Doctor in his Treatiſe *de Natura Salis Cathartici Amari*, Chap. 2. ſays, that in the Evaporation of any of the bitter Purging Waters, they yield a Cremor at Top, as alſo a Sediment, both together weighing 6, 8, or about 10 Drains, from a Gallon of Water; and that the leſſer Part of this Sediment is, in Subſtance,
the

the same with this Cremor; the rest is all Salt, but consists of two sorts, one a muriatick Salt, the other which is proper or peculiar to these Waters.

In the *Epsom* Water, the muriatick Salt is about a 20th Part of the saline Mixture; in the *Dulwich* it is in a greater Proportion, and the same in several others; it is, both in its acrimonious Taste and Figure of its Crystals, not unlike to common Salt. The other Salt is that which he says is particular or proper to the purging Waters, and is [made by Evaporation and Crystallization. In this Preparation, first the earthy or plastery Part is to be separated, next the muriatick Salt, and, lastly, a brown and dark Liquor from the proper Salt of the Waters.

And in the 4th Chapter of the same Part, having shewn the Difference of the Figure betwixt the Crystals of this Salt and those of Alum, he goes on, Neither is there any better Ground to account the purging Salt a Species of common Salt, from which being perfectly freed, it differs as much in Taste as from Alum. And in the same Chapter, he says it will appear, the bitter purging Salt, although it hath some Qualities in common with other Salts, yet is truly, or specifically different from them all. Thus far *Dr. Grew*.

Now I cannot see any Thing in this Account, but what will, *consideratis considerandis*, very well agree with the purging Salt from the Sea Water.

For first, there is an earthy or plastery Part contain'd in these Waters, and this must be separated. The very same is in the Sea Water, and is precipitated in the Boiling them down, as has been observ'd, and by the Operators is called *Scratch*.

Next there is a muriatick Salt allow'd to be in these Waters; in some more, in some less, and this is likewise

likewise to be separated: The very same is done from the Sea Water, though in a vastly larger Proportion.

And, lastly, there is a black and dark Liquor to be separated; tho' this is but a dark Way which the Doctor makes use of to express himself, it cannot be better explain'd, than by what has been found to be Fact in boiling down the Waters at *Shooters-Hill*: That after several Shootings of Salts by repeating the Boilings of the Waters, there would, at last, remain a Liquor of a deep brown Colour, which would no longer yield a crystaliz'd Salt; but if boil'd up dry, would afford a Salt of the same Kind with the third Salt already mention'd: And this explaining Dr. *Grew's* black and dark Liquor, helps at the same time to prove, in this Article too, that the Sea Water affords the same kind of third Salt.

I have try'd several of the Experiments mention'd by the Doctor, by which he distinguishes his Salt from other Salts. Such as not affecting the Colour of Syrup of Violets; curdling of Milk when boil'd; in the Figure of its Crystals; in its easy Dissolution in the same Quantity of Water; in its coagulating with the *Ol. Tartar. per D. L.* in its Calcination, and in the Bitterness of its Taste, as well before as after Calcination, &c. and find this Salt, thus separated from the Sea Water, answer to all the Tryals. Some few Experiments, that the Doctor has not taken Notice of, I shall here subjoin, and then leave the Whole to the Opinion of better Judges; Whether there be any specifical Difference between these two Salts?

In order to have a Standard for these Experiments, I purposely got my Friend, Mr. *Hyet*, Apothecary at *Epsom* (whose Fidelity I could depend on) to boil me down some of their Waters, which he did from the
Well

Well in the Town, and sent me a sufficient Quantity of the Salts, to answer the Purpose I wanted them for.

I procured likewise some of the first Salts from the *Lemington Bittern*: These do not hold so much of (what I have already distinguished by the Name of) the third Salt, as I find the *Newcastle* Salts do. This *Lemington* Salt, I, for Distinction sake, call the *first Lemington Salt*.

Part of this I dissolv'd, and shot into pure *Sal Catharticum*, being freed, as well from the Sea Salt, as the third Salt; and this I call the *second Lemington Salt*.

I procured likewise from *Newcastle* the first Salts shot from their *Bittern*, which I call the *first Newcastle Salt*.

Part of these I likewise dissolv'd and shot, and obtain'd a pure *Sal Catharticum*, and this is what I call the *second Newcastle Salt*.

I am obliged to make Use of the *Sal Mirabile*, made from the *Ol. Vitriol.* and common Salt, that having been taken for the *Sal Catharticum*.

As also common Salt, that having been represented as the principal Substance of the *Sal Catharticum*.

I took half an Ounce of each of these Salts, and dissolv'd them in about two Ounces of Water to each half Ounce of Salt.

A small Quantity of each Dissolution I pour'd into as many Glasses, and dropt into them all some *Butyr. Antimonii*. The Precipitation that follow'd, seem'd to be alike in them all; and upon dropping a little *Ol. Vitriol.* into each, what was precipitated being more powerfully attracted by the Oil, the several Liquors became clear. These are the two only Experiments, in which I found the Consequences so much alike in them all.

In the following Experiments, the *Sal Mirabile* is sufficiently distinguish'd from all the rest.

Slices of Gall cut into these several Solutions have no manner of Effect upon any, except that of the *Sal Mirabile*, which is soon ting'd of the Colour of Sack, or rather deeper.

Sp. Sal Arm. c. Tart. dropt into thê several Solutions turns them all milky, except that of the *Sal Mirabile*, which keeps its Transparency.

The *Sp. Salis Armon. c. calce.* the *Ol. Tart. p. deliq.* the *Tinctura Coccinell in Sp. Vin. fact.* do every one, used after the same Manner, sufficiently distinguish the *Sal Mirabile* from all the rest.

In the following Experiments, the *Epsom* Salt, the *second Lemington* Salt, and *second Newcastle* Salt, agree together, and differ from the common Salt, the *first Lemington* Salt, and *first Newcastle* Salt.

In the several Solutions I dropt a Solution of Silver in *Aq. Fortis*, from which follow'd these Consequences. The Solution of the *Epsom* Salt, *second Lemington* Salt, and *second Newcastle* Salt, became equally milky, before the Precipitation. The Solution of the Sea Salt, and *first Newcastle* Salt, let the Precipitation pass without receiving any milky Tinge. The *first Lemington* Salt, as holding less of the *third* Salt, than the *first Newcastle* Salt did, took a little milky Tinge. The Precipitation fell nimbly thorough the Solution of the *Sal Mirabile*, leaving it milky.

In the Condition these were in, I pour'd some *Ol. Tartar. per deliq.* to each of them, on which, after some time, a blueish Scum arose on the Surfaces of the *Epsom* Salt, *second Lemington* Salt, and *second Newcastle* Salt: There likewise appear'd a little on the *first Lemington* Salt, but not any on the rest.

A Solution of corrosive Sublimate was made in Water, ten Drops of which, mixed with the several Solutions, produced little or no Alteration ; but upon dropping in the *Ol. Tartari per deliq.* the following Appearances were produc'd : In the Solution of the *Epsom Salt*, *second Lemington Salt*, and *second Newcastle Salt*, the Precipitations were red ; in the Solution of the common Salt, and *first Newcastle Salt*, the Precipitations were white ; in the Solution of the *first Lemington Salt*, the Particles precipitated approach'd pretty near the Colour of the three first.

I took some of these several Salts in Substance, and to each of them pour'd a little *Ol. Vitriol.* which is one of the Experiments Dr. *Grew* try'd upon his Salt, and which he says causes a moderate Ebullition, whereby it appears to partake of an alkaline Principle : But without looking for this alkaline Principle from its fermenting with an Acid, (Terms justly exploded by the learned Dr. *Freind* in his *Praelectiones Chymicae*) I am inclin'd to believe, that the Salt he try'd the Experiment on, had not, according to his own Directions, been thoroughly separated from his muriatick Salt. For this Oil pour'd on the *Epsom Salt*, *second Lemington Salt*, and *second Newcastle Salt*, produc'd no sensible Fermentation. On the Sea Salt it acts with Violence, forcing off its acid Spirit with an insufferable Gas. The same Effect in proportion it had on the *first Lemington Salt*, and *first Newcastle Salt* ; none at all on the *Sal Mirabile*, as being a Sea Salt already satiated with the Oil.

What I have all along call'd the *third Salt*, answers in most of these Experiments to the Sea Salt, and yet has some Properties exceedingly different from it ; to those I have mention'd these may be added ; it will not decrepitate

crepitate like Sea Salt; it readily melts, when put in a Crucible in the Fire; and when calcin'd till red-hot, affords a *Calx* equal to, if not stronger than a Limestone, and ferments violently, as well with Water as with *Ol. Vitriol*. This *Calx*, when expos'd to a moist Air, will Part of it run *per deliq.* but not so soon as before Calcination. All these Properties differ in every Respect from the common Salt, and leave me still in doubt what to call it, as also how far Experiments of this Kind may be deem'd conclusive.
